Integrating 3D vision & Laser Scanning for a Marine Robot

An ELE Senior Design Project (2-3 ELE & ECE)

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This project would develop robot navigation and decision making capabilities through the integration of 3 dimensional distance measuring capabilities of a scanning laser with automated tilt platform and a stereo camera system with 3D distance calculations. The hardware and software capabilities are to be applied to the URI Autonomous Surface Vessel developed by the Ocean Engineering Department for the upcoming June 2012 competition sponsored by the Association for Unmanned Vehicle Systems International (AUVSI). This vehicle placed 1st of 15 international teams in 2011 with sponsorship from Battelle, Raytheon, COEUT/NUWC, Matlab and others; and with vision support from and ELE senior design team. Background on the vehicle is provided below. Background on the competition can be found at www.auvsi.org. Background on the new STOC 3D camera system can be found at www.videredesign.com. Background on the scanning laser can be found at www.hokuyo-aut.jp/ 02sensor /07scanner/urg_04lx_ug01.html.

***Abstract** –URI's student ASV (RAMboat2010- fig. 1), based on a Hobie Float Cat 60, is a stable, ultra-maneuverable platform first designed as a generator-powered robot AUV tender for Narragansett bay by Ocean Engineering seniors, then modified for the ASV competition. A watertight electronics box is mounted forward of the payload space, with a camera, GPS, and water cannon mounted on the forward scaffolding. A droppable Velcro bumper is mounted forward for ring retrieval and disposal. RAMboat electronics were adapted from URI's student AUV, with higher power for the ASV. They include an Intel Atom PC running OpecnCV for image processing, custom Netburner 5282 mission computer with electronic compass, one watt wireless hub for communication and programming, and custom power management board. The power board combines battery packs, produces supply voltages, monitors consumption, optically isolates computers, and allows radio control takeover of motors. A dual channel motor controller sits beside the power board to provide power to the dual Prowler T30 trolling motors. RAMboat power consists of custom 14.4 volt lithium poly motor and system battery packs. The mission computer runs a linked list table of mission legs which include speed, heading, GPS waypoints, and actions requests. Besides water cannon fire and extension pickup arm operations, the primary leg based requests are for vision guidance from the Intel Atom PC, including camera pan/tilt angles. The vision analysis preformed on the Intel Atom can be*

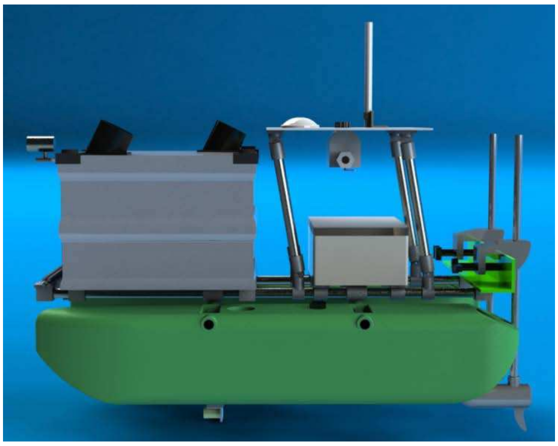

Figure 1: RAMboat 2010 CAD drawing

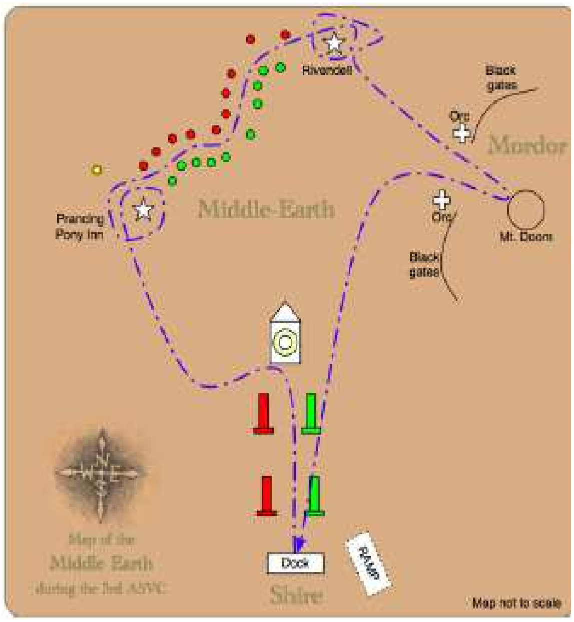

Figure 2: ASV Competition site tasks 2010

used to provide leg modifiers which control vessel guidance as well as ring retrieval and cannon fire.

1. Introduction

RAMboat2011-ASV is the 3nd entry from the University of Rhode Island (URI) in the AUVSI International ASV competition, though URI has been a participant in AUVSI AUV student competitions for over a decade. With compatible new electronics developed for URI's 2009 AUV, it was decided to adapt them to URI's new high powered ASV, and tackle the 8 surface missions planned for Virginia Beach (fig. 2). With limited funds and the need for both AUV and ASV electronics, a design criterion was that the ASV use compatible AUV hardware as much as possible. This includes a custom 5282 mission computer with compass and sonar systems attached, wireless hub for communications and programming, and new Intel Atom PC for OpenCV vision along with USB cameras. Additionally a modified RV water pump was employed as a water cannon and a linear actuator ball grabber was designed.

Work on URI ASV development began early in 2010 with a team of 7 students developing an ASV to operate semi-autonomously for 6 hours while providing live updates via long-range 2.4GHz wireless for a course at URI. The conclusion of the semester marked the beginning of competition ASV development. Considerable modifications were made to put the overweight ASV developed for class into completion form. Students divided into working groups for Hardware, Electronics, Computing, and Vision. Figure 3 represents an overall block diagram of ASV subsystems. The competition vehicle easily made the AUVSI finals where it place 3rd of 15 teams. In 2011 an updated version of our robot won the competition with the help of an ELE senior design team.

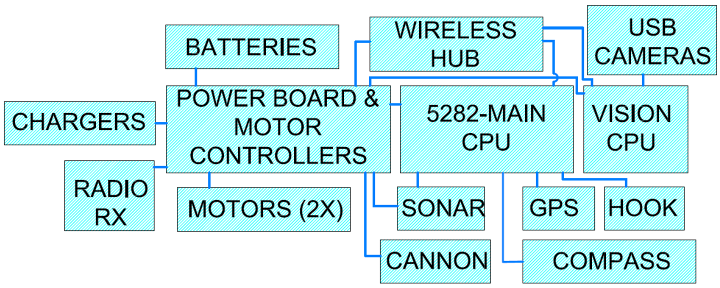

Figure 3: ASV subsystems block diagram

Pictured below are a Stereo 3D camera (left) from VidereDesign with onboard "disparity" processing for distance measurement, and the Hokuyo 4m range scanning laser system (right). For 2011 we are looking to upgrade these sensors for 3D mapping with higher resolution cameras and an automated tilt system for 3D laser operations.